Volume 4

1962-1963

STATE OF ALASKA

William A. Egan, Governor

ANNUAL REPORT OF PROGRESS, 1962 - 1963

FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-4

SPORT FISH INVESTIGATIONS OF ALASKA

Alaska Department of Fish and Game

Walter Kirkness, Commissioner

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Sport Fish Division

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INTRODUCTION

This report of progress consists of Job Segment Reports from the State of Alaska Federal Aid in Fish Restoration Project F-5-R-4, "Sport Fish Investigations of Alaska".

The project is composed of 25 separate studies designed to evaluate the various aspects of the State's recreational fishery resources. While some studies are of a more general nature and deal with gross investigational projects, others have been developed to evaluate specific problem areas. These include studies of king salmon, silver salmon, grayling and State Access requirements. The information gathered will provide the necessary background data for a better understanding of local management problems and development of future investigational studies.

The assembled progress reports may be considered fragmentary in many respects due to the continuing nature of the respective studies. The interpretations contained therein, therefore, are subject to re-evaluation as work progresses and additional information is acquired.

Volume 4 Report No. 8-C-2

JOB COMPLETION REPORT

RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska.

Project No. F-5-R-4 Title: Mirror Lake Aeration Study

Job No: 8-C-2

Period Covered: July 1, 1962 to June 30, 1963

Abstract:

The aeration equipment was not utilized because dissolved oxygen concentrations remained above 5 ppm. The highest concentrations of carbon dioxide encountered were 15 ppm. Ice cover accumulated to a depth of 34 inches on March 28. The deepest snow depth recorded on Mirror Lake, for any one period, was 7 inches. The mean depth was 2.3 inches. Both the lake inlet and outlet remained free of ice throughout the winter. A few anglers fished up until mid-winter taking a small number of 6-12 inch silver salmon; no rainbow trout were observed caught. Shortly after the ice had gone out, the shorelines were walked out to enumerate winter-kill; only six dead fish were observed.

Recommendations:

It is recommended that this project be discontinued. At no time, during the winter, did the dissolved oxygen concentrations get below the minimum required for fish survival. Literature review has also illustrated that aeration projects undertaken in other areas have failed to curb "winter-kill". There is also the strong possibility that air-induced circulation causes winter-kill rather than preventing it, according to a report of the Rifle River Research Station in Michigan.

Objectives:

To measure the effectiveness of mechanical aeration in Mirror Lake.

Techniques Used:

In mid-December, an air compressor was set up on the shore of Mirror Lake. Two hundred fifty feet of non-perforated and 1000 feet of perforated, weighted plastic hose was layed out under the ice with the aid of a mechanical "ice-jigger" to the desired positions.

Water samples were collected, from November 21, 1962, to May 8, 1963, by a Kemmerer sampler (Figure 1) and analyzed for dissolved oxygen, carbon dioxide, total alkalinity and pH by the use of standard methods. Snow covered and ice thickness measurements were also taken.

Findings:

Mirror Lake is a shallow, oligotrophic lake containing sixty-five surface acres and is located on the main highway about 22 miles east of Anchorage. The mean depth is approximately four to five feet with a maximum depth of ten feet. The entire lake bottom is covered with deep organic ooze to depths exceeding 24 inches. Due to the relatively low productivity of this lake, the growth of vascular aquatic plants and phytoplankton is low. A few springs and/or seepage areas are found in the bottom of this lake and flow throughout the winter. Undoubtedly, this aids in fish survival by adding oxygen to the lake during periods of thick ice and snow cover.

The fish populations are composed principally of silver salmon (Oncorhynchus kisutch) and rainbow trout (Salmo gairdneri).

On December 13, 1962, 1250 feet of weighted, plastic hose was put through 14 inches of ice with the aid of an "ice-jigger" and stretched out for operation, and an air

Figure 1

Water Samples being collected at Station 5 on Mirror Lake. Note the insulated box utilized in preventing water samples from freezing.

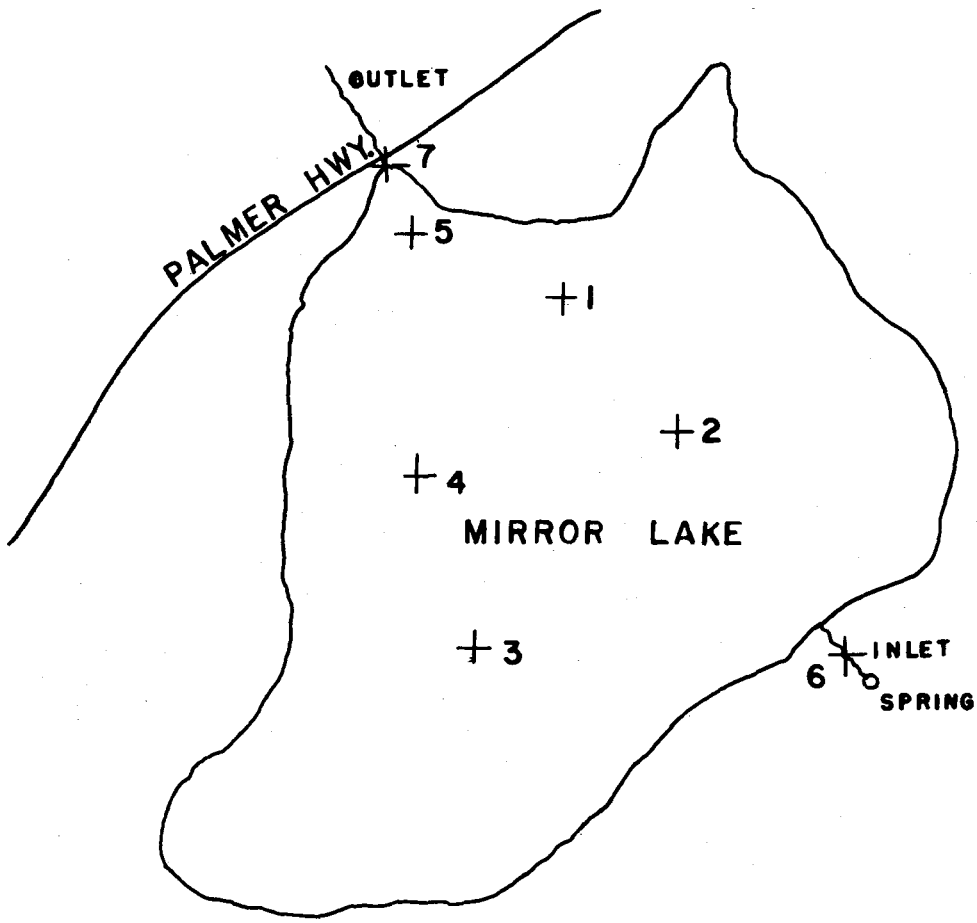

FIGURE 2.— Location of sampling stations on Mirror Lake, inlet and outlet.

compressor installed. The compressor was scheduled to go into operation when the dissolved oxygen concentrations dropped below 5 ppm. However, due to the high levels of dissolved oxygen throughout the winter the air compressor was not utilized.

Beginning November 21, 1962, up until May 8, 1963, water samples were collected weekly, except for the week of January 2, at which time the air temperatures dropped to a minus 21° F. and the collecting equipment froze while in the process of obtaining samples. These samples were collected from five stations on Mirror Lake and at the outlet and inlet (Figure 2). The water depths at stations 1 through 5 on Mirror Lake are as follows:

6.5, 7.0, 7.0, 8.0 and 4.5 feet, respectively.

The dissolved oxygen concentrations peaked between December 20 and 31 (Figure 3) and gradually diminished with occasional slight fluctuations up until April 5 at which time they increased slightly at stations 3, 4 and 5. The highest dissolved oxygen concentration, from November 21 to May 8, occurred on December 28 at the surface with 12.5 ppm at stations 1 and 2, and a low of 3.8 ppm occurred on March 6 at station 4 at the 5 foot depth. The differentials of dissolved oxygen between the surface and 5 foot depths are presented in Figure 3. Mean concentration of dissolved oxygen was approximately 7 ppm in Mirror Lake.

The average carbon dioxide concentration (Figure 4) for the five stations, during the same period, was approximately 7 ppm with the highest concentration, 15 ppm, occurring during the latter part of February at station 2, and a low of 1 ppm at stations 3, 4 and 5 on May 8. Presented in Figure 4 are the differentials in carbon dioxide levels at the surface and five foot depths as recorded at stations 3 and 4.

Mean concentration of total alkalinity (Figure 5) for the five stations on Mirror Lake was approximately 100 ppm on February 20 and a low of 18 ppm at the surface on May 8. Also presented in Figure 5 are the differentials of total alkalinity between the surface and five foot depths at stations 3 and 4.

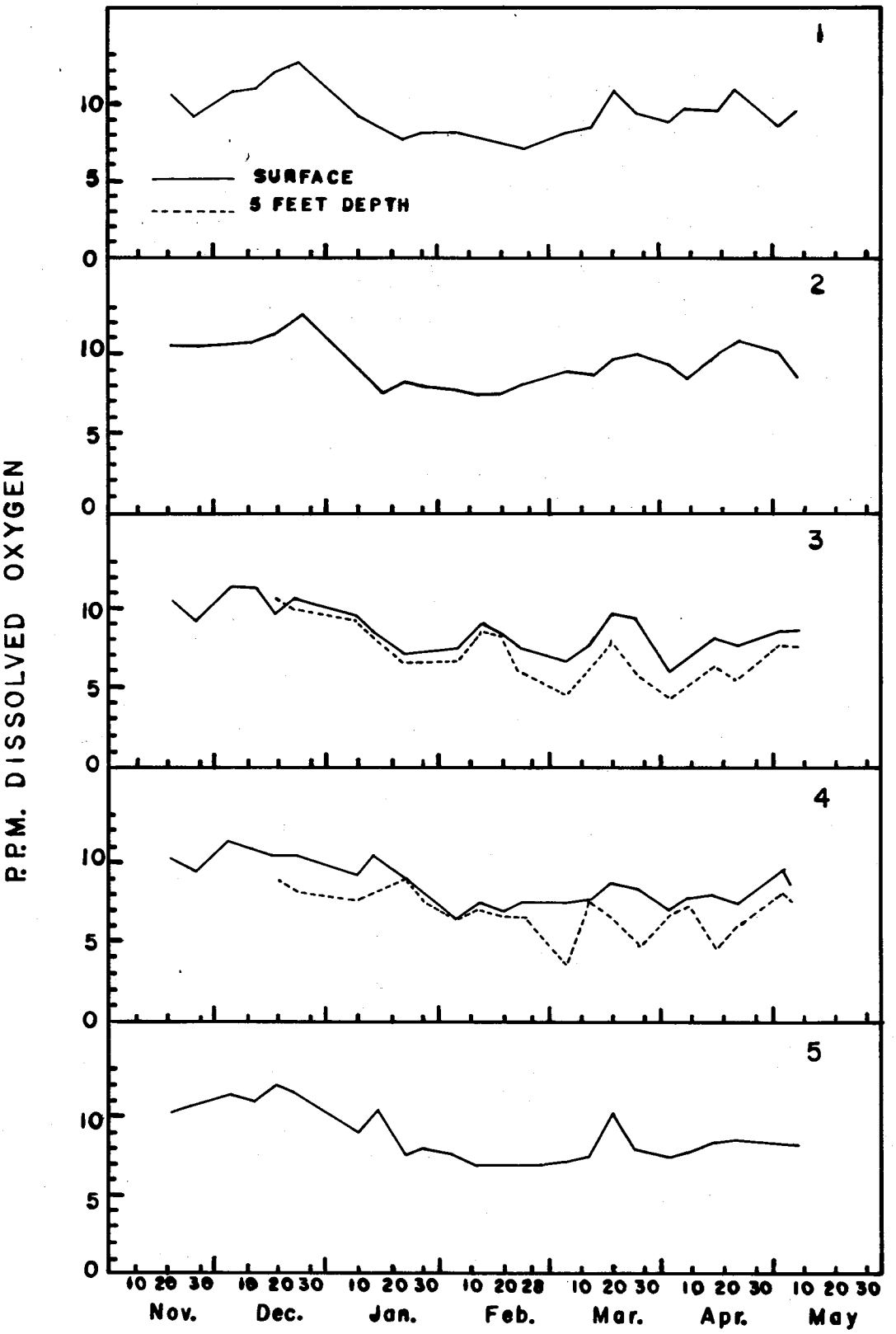

FIGURE 3.—Dissolved oxygen concentrations at 5 stations in Mirror Lake from November 21, 1962 to May 8, 1963.

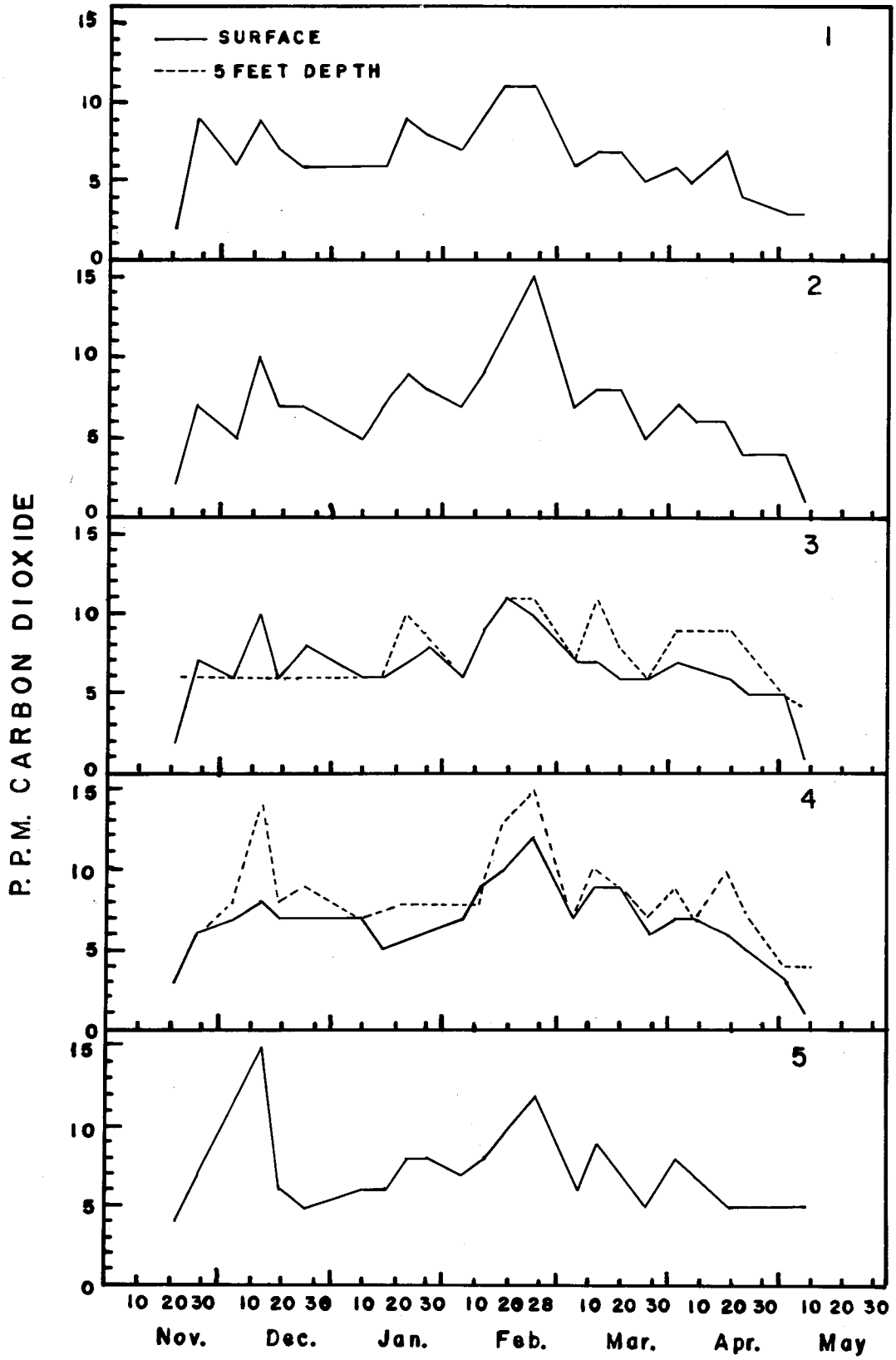

FIGURE 4.– Carbon dioxide concentrations at 5 stations in Mirror Lake from November 21, 1962 to May 8, 1963.

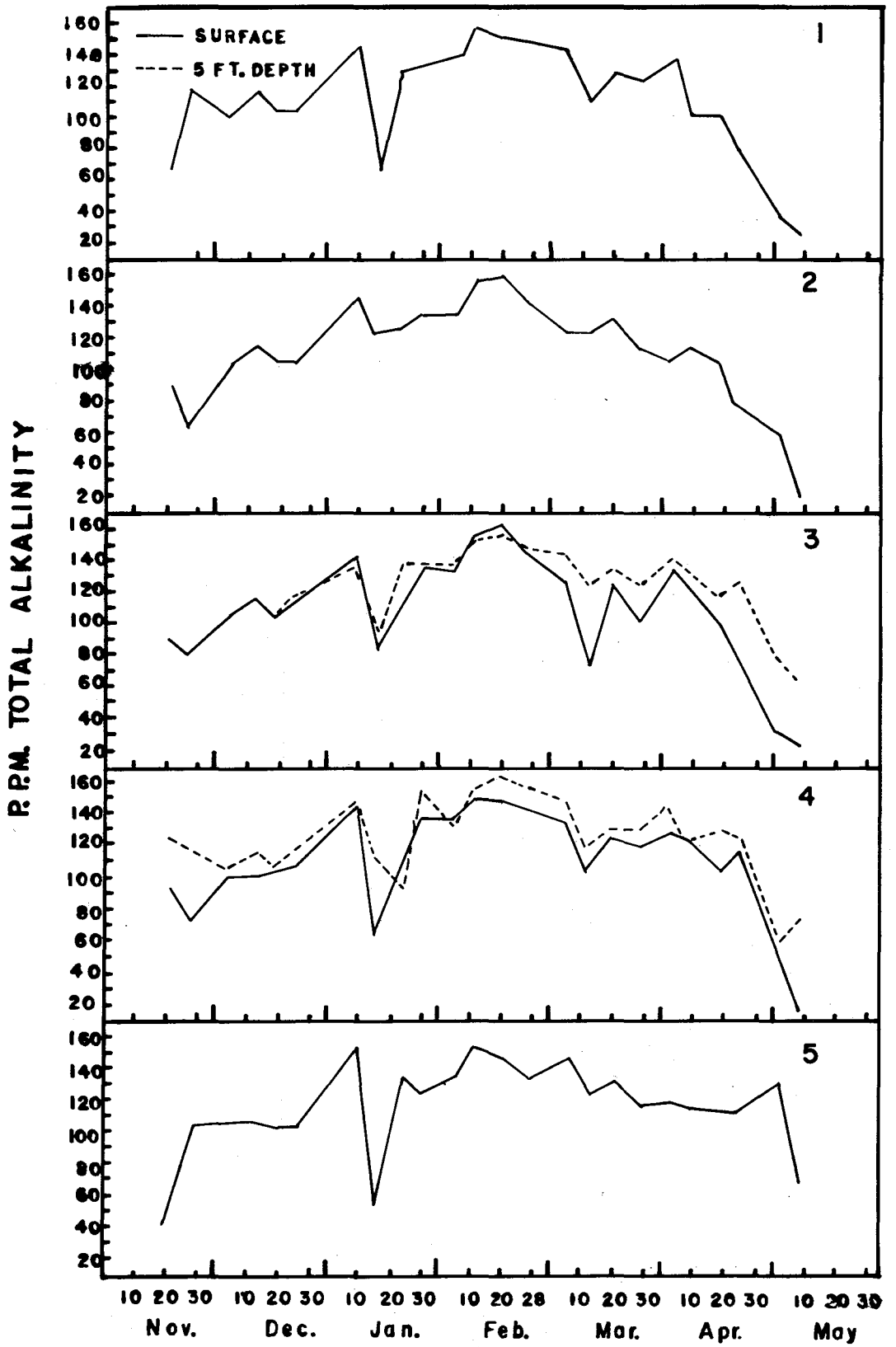

FIGURE 5.— Total alkalinity concentrations at 5 stations in Mirror Lake from November 21, 1962 to May 8, 1963.

The pH concentrations ranged from a high of 7.8 occurring during the first of December and a low of 6.8 during early May. Between the surface and five foot depths, (Figure 6, stations 3 and 4), the pH fluctuations were very slight.

Deepest snow depth recorded on the lake, for any one period was 7 inches; the mean depth was 2.3 inches (Table 1). During the winter, accumulation of snow on the lake was not great because of wind action.

Ice began forming on the lake during the latter part of October and by November 21, 9 inches had formed. On January 10, the ice depth was 25 inches and on March 28 had attained a maximum depth of 34 inches; mean depth for the winter being 26 inches. In early May the ice cover on the lake was observed to be getting "rotten" and during the week of May 19 it completely disappeared.

The surface water temperatures fluctuated between 32° F. and 34° F. at station 4, with an average of 33° F. (Table 1). In the latter part of April the temperatures began rising slightly. During the winter, at the five foot depths, the water temperatures fluctuated from 32° F. to 37° F. On April 18, they rose to 38° F. and by May 8 had increased to 41° F. The mean temperatures at the five foot depth during the winter was 35° F. The greatest temperature differentials, occurring from November 21 to May 8 between the surface and five foot depths, was 5° F. with an average differential of 1.7° F., which indicates the possibility of a slight stratification in water temperatures in this shallow lake.

Spring turnover occurred between May 2 and May 8 as indicated by the sudden change in water temperatures between the inlet and outlet (Table 4).

Air temperatures are presented for this period of study in Table 1.

INLET STREAM TO MIRROR LAKE

This small stream, averaging 30 inches wide, originates from a spring approximately 300 feet from the lake (Figures 7 and 8). During the winter months, it was free of ice for the most part, except where it entered the lake.

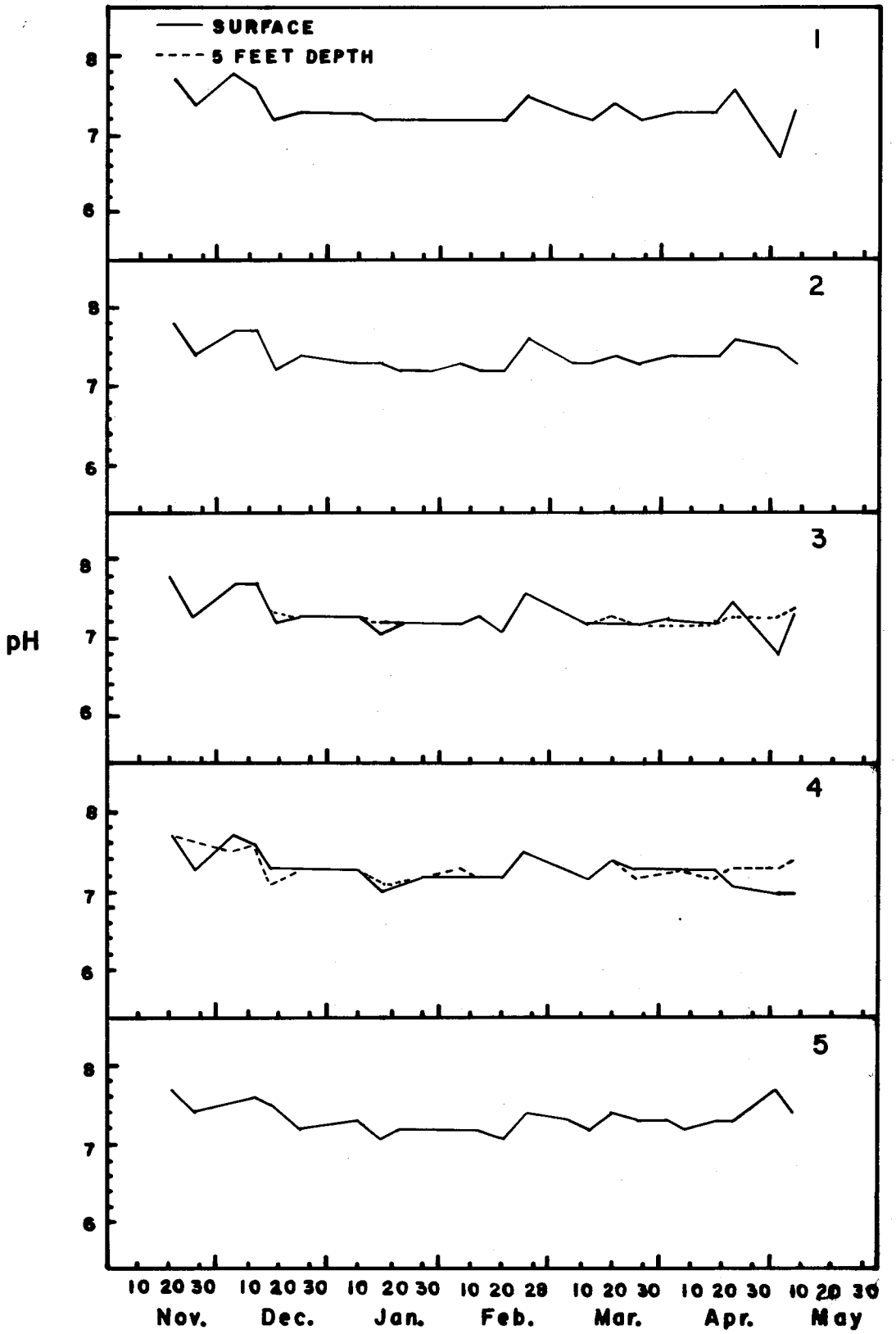

FIGURE 6.— pH concentrations at 5 stations in Mirror Lake from November 21, 1962 to May 8, 1963.

Figure 7. Inlet stream to Mirror Lake

Figure 8. Inlet stream draining into Mirror Lake. In the left corner of the lake is the outlet.

Table 1. Some physical characteristics of Mirror Lake during the winter, 1962-63

Date	Snow Depth	Ice Depth	Air Temp.	Water Temp. (Surface Sta. # 4)	Water Temp. (5 feet depth Sta. # 4)	Water Temp. Differ.
11-21-62	2.0 inches	9.0 inches	32° F.	34° F.	36° F.	+2
11-28-62	2.0 "	14.0 "	15° F.	32° F.	32° F.	0
12- 5 62	3.0 "	14.0 "	-15° F.	32° F.	36° F.	+4
12-12-62	1.5 "	14.0 "	27° F.	33° F.	34° F.	+1
12-19-62	2.0 "	18.0 "	26° F.	34° F.	36° F.	+2
12-26-62	0.0 "	19.0 "	27° F.	33° F.	36° F.	+3
1-10-63	4.0 "	25.0 "	14° F.	34° F.	34° F.	0
1-16-63	0.0 "	25.0 "	29° F.	34° F.	34° F.	0
1-23-63	0.0 "	27.0 "	32° F.	33° F.	34° F.	+1
1-30-63	0.0 "	27.5 "	20° F.	34° F.	34° F.	0
2- 6-63	0.5 "	30.0 "	6° F.	33° F.	36° F.	+3
2-12-63	5.0 "	31.0 "	27° F.	32° F.	32° F.	0

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Table 1)Con't)

Date	Snow Depth	Ice Depth*	Air Temp.	Water Temp. (Surface Sta. # 4)	Water Temp. (5 feet depth Sta. # 4)	Water Temp. Differ.
2-20-63	7.0 inches	31.5 inches	8° F.	32° F.	33° F.	+1
2-27-63	4.0 "	31.0 "	23° F.	32° F.	33° F.	+1
3- 6-63	0.0 "	30.0 "	36° F.	33° F.	37° F.	+4
3-13-63	3.0 "	32.0 "	17° F.	32° F.	33° F.	+1
3-20-63	4.0 "	32.5 "	22° F.	32° F.	33° F.	+1
3-28-63	3.0 "	34.0 "	20° F.	32° F.	35° F.	+3
4-3 -63	1.5 "	33.0 "	40° F.	34° F.	34° F.	0
4-9 -63	4.5 "	34.0 "	31° F.	32° F.	34° F.	+2
4-18-63	6.0 "	33.0 "	24° F.	33° F.	38° F.	+5
4-24-63	2.0 "	33.0 "	41° F.	35° F.	36° F.	+3
5-2 -63	0.0 "	28.0 "	53° F.	38° F.	40° F.	+2
5-8 -63	0.0 "	23.0 "	50° F.	40° F.	41° F.	+1

* The ice went off Mirror Lake during the week of May 19, 1963

Silver salmon fingerlings were periodically seen congregated in this stream throughout the winter. The number of fish observed for any given time ranged up to about 30 with lengths varying from 1 to 4 inches.

The average water temperature was 35° F., but varied from 34° F. to 37° F. (Table 2). Stream flows ranged from 0.1 to 0.5 c.f.s.

Chemical characteristics of the water are as follows: a high concentration of dissolved oxygen existed throughout the winter months, ranging from 9.3 ppm to 10.8 ppm, with a mean of 10.1 ppm. Carbon dioxide concentrations fluctuated from 3 ppm to 6 ppm with a mean level of about 4 ppm. The hydrogen ion concentrations remained relatively stable with minimum levels of 7.3 on January 23 to a maximum of 7.8 on May 8. Total alkalinity fluctuated from 91 ppm to 146 ppm, with the mean being about 110 ppm.

OUTLET STREAM TO MIRROR LAKE

This outlet stream (Figure 9), flows through a 36 inch culvert under the Palmer Highway and meanders out to Knik Arm. The outlet remained free of ice throughout the winter.

Only one small fish was observed while collecting water samples at the outlet from January 23 to May 8.

The mean water temperature (Table 3) was 34° F. with a range of 32° F. to 42° F. Stream flows from this lake ranged from 0.7 c.f.s. throughout most of the winter to about 1.5 c.f.s. during the ice break-up. The consistently higher flows at the outlet in comparison with inlet suggests that one or more springs are found in the bottom of this lake. During November and early December, a hole in the ice averaging 18 inches in diameter, located between stations 4 and 5, remained open. It is believed the warm upwelling of a spring caused this hole.

Chemical and physical characteristics of the outlet are presented in Table 3.

Table 2. Air temperatures and chemical and physical characteristics of the Inlet stream draining into Mirror Lake from January 23, 1963 to May 8, 1963.

Date	Water Temp.	Air Temp.	D. O.	CO_2	pH	Total Alkalinity
1-23-63	35° F.	32° F.	9.4	6.0	7.3	112
1-30-63	35° F.	20° F.	9.8	6.0	7.3	111
2-6 -63	34° F.	6° F.	9.6	4.0	7.3	93
2-12-63	35° F.	27° F.	10.2	5.0	7.3	98
2-20-63	34° F.	7° F.	10.5	5.0	7.3	121
2-27-63	34° F.	20° F.	9.3	5.0	7.6	101
3-6 -63	35° F.	37° F.	10.3	4.0	7.5	91
3-13-63	34° F.	17° F.	10.3	6.0	7.4	123
3-20-63	35° F.	22° F.	10.3	5.0	7.6	146
3-28-63	35° F.	18° F.	10.0	4.0	7.5	117
4-3 -63	36° F.	42° F.	10.0	4.0	7.5	116

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Table 2 (Con't)

Date	Water Temp.	Air Temp.	D. O.	CO_2	pH	Total Alkalinity
4-9 -63	36° F.	30° F.	10.3	5.0	7.4	90
4-18-63	36° F.	26° F.	10.8	5.0	7.4	93
4-24-63	37° F.	40° F.	10.5	4.0	7.4	95
5-2 -63	37° F.	53° F.	10.2	4.0	7.7	93
5-8 -63	34° F.	50° F.	10.7	3.0	7.8	96

Table 3. Chemical and physical characteristics of the Outlet stream to Mirror Lake from January 23, 1963 to May 8, 1963.

Date	Water Temp.	Air Temp.	D.O.	CO_2	pH	Total Alkalinity
1-23-63	33° F.	32° F.	7.6	10.0	7.3	129
1-30-63	35° F.	23° F.	7.5	8.0	7.2	133
2-6 -63	34° F.	6° F.	8.0	7.0	7.2	140
2-12-63	33° F.	25° F.	7.2	11.0	7.1	159
2-20-63	33° F.	18° F.	6.8	11.0	7.1	167
2-27-63	33° F.	33° F.	6.0	19.0	7.4	146
3-6 -63	32° F.	37° F.	6.7	7.0	7.4	146
3-13-63	33° F.	18° F.	7.6	9.0	7.2	103
3-20-63	33° F.	24° F.	8.3	8.0	7.5	137
3-28-63	32° F.	19° F.	7.4	6.0	7.4	135
4-3 -63	34° F.	40° F.	7.5	9.0	7.3	142

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Table 3 (Con't)

Date	Water Temp.	Air Temp.	D. O.	CO_2	pH	Total Alkalinity
4-9 -63	33° F.	29° F.	6.9	6.0	7.2	115
4-18-63	33° F.	26° F.	8.6	8.0	7.3	108
4-24-63	35° F.	40° F.	9.5	8.0	7.3	108
5-2 -63	36° F.	54° F.	7.8	4.0	6.7	38
5-8 -63	42° F.	50° F.	7.6	2.0	6.8	20

Differentials between some of the chemical and physical characteristics of the inlet and outlet to Mirror Lake are presented in Tables 4 and 5.

ICE FISHING

A few anglers were occasionally observed fishing through the ice while collecting water samples on Mirror Lake (Fisure 10). On December 13, five anglers were interviewed. They had fished a combined total of 16 hours and caught 22 silver salmon which ranged in length from 8 to 12 inches, with a catch rate of 1.4 fish per hour. Occasionally some small silver salmon, 3 to 5 inches in length, would be found on the ice next to a fishing hole, indicating possibly a considerable number of these small fish were being discarded.

WINTER-KILL

On June 6, the entire shoreline of Mirror Lake was walked in an effort to check on possible winter-kill. A total of six partially decayed fish were counted along the west shoreline. These fish ranged in length from 6 to 23 inches. The largest fish observed was undoubtedly a rainbow trout, while the remainder were too decomposed to determine species. While searching for dead fish, several 5-9 inch fish were observed surfacing in various areas of the lake.

A few days later, a 125 foot, variable mesh, experimental gill net was set overnight in the deepest section of the lake for a period of 14.5 hours and only two silver salmon, 6.0 and 8.3 inches in length, were caught. A reason for the small number of fish taken may be partially explained as a result of the long daylight hours which enabled these fish to avoid the net. Another possibility for the low catch may be a result of migrating out of the lake, as was occurring in Lower Fire Lake at the time.

DISCUSSION

North Dakota State Game and Fish Department reports that thousands of dollars have been spent by various states,

Table 4. Differentials between water temperatures, dissolved oxygen, and carbon dioxide at the inlet and outlet to Mirror Lake from January 23, 1963 to May 8, 1963.

Date	Inlet Water Temp.	Outlet Water Temp.	Diff.	Inlet D.O.	Outlet D.O.	Diff.	Inlet CO_2	Outlet CO_2	Diff.
1-23-63	35°F.	33°F.	-2	9.4ppm	7.6ppm	-1.8	6ppm	10ppm	+4
1-30-63	35°F.	35°F.	0	9.8 "	7.5 "	-2.3	6 "	8 "	+2
2- 6-63	34°F.	34°F.	0	9.6 "	8.0 "	-1.6	4 "	7 "	+3
2-12-63	35°F.	33°F.	-2	10.2 "	7.2 "	-3.0	5 "	11 "	+6
2-20-63	34°F.	33°F.	-1	10.5 "	6.8 "	-3.7	5 "	11 "	+6
2-27=63	34°F.	33°F.	-1	9.3 "	6.0 "	-3.3	5 "	19 "	+14
3- 6-63	35°F.	32°F.	-3	10.3 "	6.7 "	-3.6	4 "	7 "	+3
3-13-63	34°F.	33°F.	-1	10.3 "	7.6 "	-2.7	6 "	9 "	+3
3-20-63	35°F.	33°F.	-2	10.3 "	8.3 "	-2.0	5 "	8 "	+3
3-28-63	35°F.	32°F.	-3	10.0 "	7.4 "	-2.6	4 "	6 "	+2
4- 3-63	36°F.	34°F.	-2	10.0 "	7.5 "	-2.5	4 "	9 "	+5
4- 9-63	36°F.	33°F.	-3	10.3 "	6.9 "	-3.4	5 "	6 "	+1

Continued on page

Table 4 (Con't)

Date	Inlet Water Temp.	Outlet Water Temp.	Diff.	Inlet D.O.	Outlet D.O.	Diff.	Inlet CO_2	Outlet CO_2	Diff.
4-18-63	36°F.	33°F.	-3	10.8ppm	8.6ppm	-2.2	5ppm	8ppm	+3
4-24-63	37°F.	35°F.	-2	10.5 "	9.5 "	-1.0	4 "	8 "	+4
5- 2-63	37°F.	36°F.	-1	10.5 "	7.8 "	-2.4	4 "	4 "	0
5- 8-63	34°F.	42°F.	+8	10.7 "	7.6 "	-3.1	3 "	2 "	-1

Table 5. Differentials between pH and total alkalinity at the inlet and outlet to Mirror Lake from January 23 to May 8, 1963.

Date	Inlet pH	Outlet pH	Diff.	Inlet Total Alkalinity	Outlet Total Alkalinity	Diff.
1-23-63	7.3	7.3	0	112ppm	129ppm	+17
1-30-63	7.3	7.2	-0.1	111 "	133 "	+22
2- 6-63	7.3	7.2	-0.1	93 "	140 "	+47
2-12-63	7.3	7.1	-0.2	98 "	159 "	+71
2-20-63	7.3	7.1	-0.2	121 "	167 "	+46
2-27-63	7.6	7.4	-0.2	101 "	146 "	+45
3- 6-63	7.5	7.4	-0.1	91 "	146 "	+55
3-13-63	7.4	7.2	-0.2	123 "	103 "	-20
3-20-63	7.6	7.5	-0.1	146 "	137 "	- 9
3-28-63	7.5	7.4	-0.1	117 "	135 "	+18
4- 3-63	7.5	7.3	-0.2	116 "	142 "	+26
4- 9-63	7.4	7.2	-0.2	90 "	115 "	+25

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Table 5 (Con't)

Date	Inlet pH	Outlet pH	Diff.	Inlet Total Alkalinity	Outlet Total Alkalinity	Diff.
4-18-63	7.4	7.3	-0.1	93ppm	108ppm	+15
4-24-63	7.4	7.3	-0.1	95 "	108 "	+13
5-2 -63	7.7	6.7	-1.0	93 "	38 "	-55
5-8 -63	7.8	6.8	-1.0	96 "	20 "	-76

Figure 9. Water temperature being taken at the outlet of Mirror Lake.

Figure 10. Anglers fishing through the ice on Mirror Lake.

including North Dakota, to devise methods of preventing winter-kill. Pumps, outboard motors, windmills, lampblack and snow removal have been tried. All of these methods have proved inadequate and in no recorded instance has a lake of any size been brought through the winter by artificial means. The only apparent cure for winter-kill is the raising of the water level to create more volume of water for oxygen storage.

Rather than waste effort and money trying to make these winter-kill lakes produce a fishery, the North Dakota State Game and Fish Department directed its efforts toward the development of the lakes that are free of this stigma.

During the winters of 1956-57 and 1957-58, and experimental aeration program was initiated by the Utah State Department of Fish and Game (Dotson, 1962) on a large shallow lake to prevent winter-kill. A compressor and several hundred feet of perforated hose were used to pump air into the depths of the lake. The aeration project succeeded in opening up a section in the ice, but it did not prevent the loss of a substantial number of trout.

Schmitz (1959) states that there are biological limits on the use of aeration equipment. For example, assuming that the deeper waters of a lake are already depleted of oxygen before aeration commences, when artificial circulation starts the mixing of deeper oxygen poor waters would dilute what little oxygen remained in the upper waters for the fish.

Research has also shown that in some instances, the "functional" fertility of the water can actually be enhanced by such artificial circulation. In lakes this is not always desirable, simply because fertility utilizes oxygen and therefore is one of the contributors to winter-kill.

Experimental work cone on two Michigan lakes by compressed air by the Rifle River Fisheries Research Station (Patriarche, 1961), during the winters of 1957-58, 1958-59 and 1959-60 indicates that there is a strong possibility that the use of air-induced circulation aided winter-kills instead of preventing them.

Literature Cited

Dotson, P. A. 1962. "Death Under Ice." Utah Department of Fish and Game Bulletin, 18 (2): 8-9.

Morgan, H. R. (No date). "What's This Winter-kill Business?" North Dakota Game and Fish Department, Pamphlet No. 3.

Patriarche, M. H. 1961. Air-induced Winter Circulation of Two Shallow Michigan Lakes. J. Wildl. Mgmt., 25(3): 282-289.

Schmitz, W. R. 1959. Research on Winter-kill of Fish. Wisconsin Conservation Bulletin, 24(2): 19-21.

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